SPASS: Scalable Event Stream Processing Leveraging Sharing Opportunities

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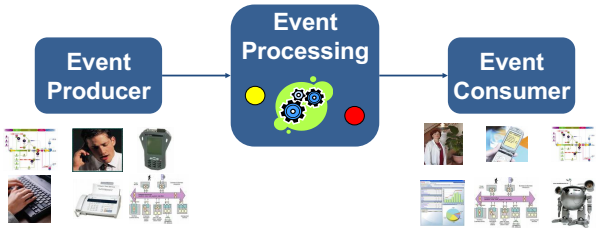
1 Motivation



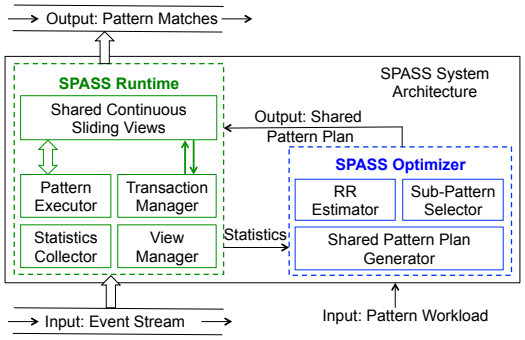
Traffic Sensor Data

Multiple Pattern Queries

```
Q1: SEQ (CarLoc c (c.pos = tollA),
CarLoc c1 (c1.pos = WorkZone, c1.id = c.id),
CarLoc c2 (c2.pos = exitA & c.id = c2.id))

Q2: SEQ (CarLoc c (c.pos = tollA),
Accident a (a.pos = tollA + 5 miles),
CarLoc c1 (c1.pos = exitA & c.id = c1.id))

Q3: SEQ (CarLoc c (c.pos = tollA),
CarLoc c1 (c1.pos = c.pos &
c1.type = EMS & c1.state = Parked),
CarLoc c2 (c2.pos = exitA & c.id = c2.id)

Q4: SEQ (CarLoc c (c.pos = tollA),
CarLoc c1 (c1.pos = WorkZone, c1.id = c.id),
CarLoc c2 (c2.pos = exitB & c.id = c2.id))
```

Multiple Pattern Queries with Common Sub-Patterns

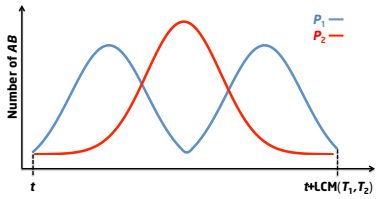
2 SPASS Architecture



- **SPASS Optimizer** builds an optimal sharing plan for entire pattern workload
- **SPASS Runtime** exploits iterative hierarchical processing to compute pattern matches

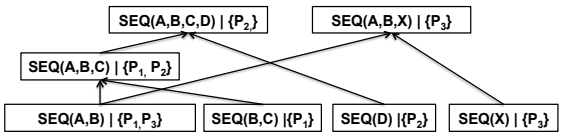
3 SPASS Optimizer

- **Challenge 1.** Non-Alignment of Cardinality of Pattern Matches



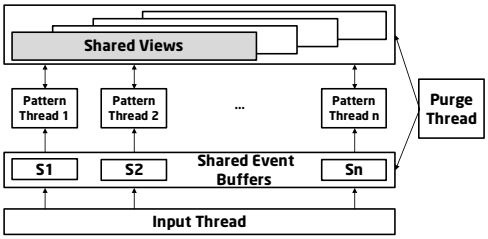
- **Observations**
  - The cardinality of the sub-pattern matches varies over time
  - The crests and troughs often may not align well
- **Intra-Query Event Correlation**
  - Number of event instances of type E_j follow an event of type E_i
  - Estimate the number of sub-pattern matches formed in a time interval
- **Inter-Query Event Correlation**
  - A ratio between
    - ✓ The number of sub-pattern matches computed with sharing
    - ✓ The number of sub-pattern matches computed independently
  - Estimate the degree of sharing possible across multiple patterns
- **Redundancy Score**
  - Estimate the degree of the redundant computation of sub-pattern matches within a time interval using both **Intra-** and **Inter-Query Event Correlations**.

- **Challenge 2.** Intractable Search Space
  - Find a subset of sub-patterns such that all pattern queries can be answered with minimal redundancy ratio
- **Solution**
  - Map to Minimum Substring Cover problem
  - Leverage a polynomial-time approximate solution with proven acceptable bounds on optimality to identify the subset of sub-patterns
  - Build shared pattern plan based on the identified sub-patterns



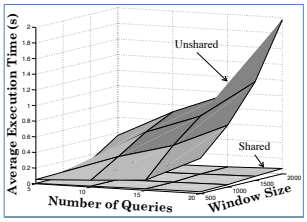
Shared Pattern Plan

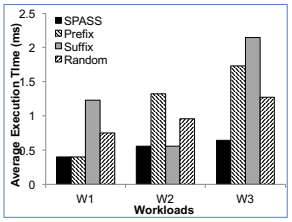
4 SPASS Runtime



- **Key challenge -** maintain result matches for sub-patterns
- **Solution**
  - Shared continuous sliding views store intermediate results of sub-patterns
  - Partial sub-pattern matches stored in sequence views
  - Subsequent reuse by accessing these materialized views associated with sub-patterns
- **Concurrent** reuse of shared continuous sliding views
  - View Validity Interval (VVI) – timestamp-based indicators associated with materialized views
  - View Lookup Interval (VLI) – a time interval to look up pattern matches

5 Experimental Results





- Window size and number of patterns increase, **SPASS** achieves more performance gains.
- On average, **SPASS** exhibits **17** times faster average execution time compared to the unshared approach.

- **W1** is characterized by 4 sets of 5 patterns sharing common prefixes across the queries
- **W2** consists of 4 sets of 5 patterns with common suffixes.
- **W3** has queries with mixed common sub-patterns.

6 Conclusion

- **SPASS** Optimizer leverages event correlations to find an effective sharing plan.
- **SPASS** Runtime then execute this shared pattern plan by exploiting the shared continuous sliding view technology.
- **SPASS** achieves many folds performance improvement in CPU utilization compared to state-of-the-art techniques.

M. Ray, **C. Lei**, and E. A. Rundensteiner: SPASS: Scalable Event Stream Processing Leveraging Sharing Opportunities. Poster, DEBS 2016: 336-339
M. Ray, **C. Lei**, and E. A. Rundensteiner: Scalable Pattern Sharing over Event Streams. SIGMOD 2016: 495-510